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Scientific and Legal Mechanisms for Addressing Model Uncertainties: Negotiating the Right Balance in Finnish Judicial Review?

Tiina Paloniitty* and Niina Kotamäki**

ABSTRACT

Environmental models are ubiquitous in assessing the environmental impacts of planned projects. Modelling is an inferential process and includes various mechanisms to address the uncertainty of the outcome. In this article, we acknowledge the continuum of uncertainty assessments and identify the legal mechanisms with which Finnish judicial review—characterised by broad scope of review and in-house expert judges—has encountered model uncertainty. Closely examining 10 waters-related cases heard by the Supreme Administrative Court of Finland, we explain the porous yet substantial boundary between science and law revealed by the cases. The cases demonstrate the elegance with which courts can strike a balance between the contingent precautionary principle, gradually decreasing scientific uncertainty, and the procedural constraints under which they operate. We conclude by analysing the traces towards reciprocity and adaptivity the cases reveal, encouraged by the iterative modelling mechanism and challenged by the constitutional restrictions on the scope of review.

KEYWORDS: Judicial review, environmental models, groundwater regulation, water governance, the EU Water Framework Directive

1. THE BOUNDARIES OF SCIENCE IN JUDICIAL REVIEW

The boundaries of science—where science ends and society begins—have been addressed in sociology,¹ and philosophers have pondered the difference between scientific questions and questions in science,² or how legal questions can influence

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1 Thomas F Gieryn, 'Boundaries of Science' in Sheila Jasanoff and others (eds), *Handbook of Science and Technology Studies* (Sage Publications 2001) 393.

2 Brian J Preston, 'Limits of Dispute Resolution Mechanisms' (1995) 13 Australian Bar Review 148, 169 refers to this distinction Passmore created when he describes environmental disputes as 'at least as much value disputes as scientific controversies'—and that scientific experts can aid in solving the latter but less so the former; J Passmore, *Man's Responsibility for Nature: Ecological Problems and Western Traditions* (Duckworth 1974) 213, 43–5.

scientific answers.³ Using environmental models in the administrative-judicial decision-making is a prime example of this boundary. Or perhaps better, the absence of it: models can be so intertwined in regulatory instruments that one cannot decipher where science ends and regulation begins.⁴ As pointed out by Lee and others, models themselves can even ‘contribute to the very possibility of governing the impact’ of major infrastructure developments.⁵ Hence, the scientific and legal processes can be understood as a continuum of normativity, where (1) gathering information; (2) analysing it with scientific models; (3) administrative decision-making drawing on those analyses; and (4) reviewing the authorisations in courts all entail axiological decisions.⁶

In this article, we focus on the uncertainty assessments that are conducted along the way. Uncertainty is addressed with various mechanisms, both scientific and legal. By way of focusing on uncertainty, we wish not to insinuate that only precise models are desirable, since uncertainty and its assessment are essential features in models. Uncertainty is, also, the discourse the judges and scientists share.⁷ Temporary permits, enhanced monitoring obligations or requests of regular permit reviews complementing the reality of gradually decreasing scientific uncertainty exemplify the legal mechanisms. Also, permit duration can be coupled with the cycles of recurrent knowledge production systems. Our cases, however, show how our example court requires at times perhaps an even unrealistically high level of certainty from models, offering a good reason to analyse more closely this science and law boundary. We delve into these mechanisms in our cases and conclude our analysis in the final section.⁸

Environmental impacts have been assessed through the history of environmental governance. Our interest in models springs from their role in contemporary law- and policy-making that embraces them.⁹ Environmental decision-making has relied on these assessments—and, depending on their mandate, courts have reviewed them. Models are often portrayed as the best and most effective solution for the assessment of environmental impacts. As with any silver bullet, they are ‘expected to magically generate answers to urgent environmental questions, often with five significant digits

3 Lena Wahlberg, *Legal Questions and Scientific Answers: Ontological Differences and Epistemic Gaps in the Assessment of Causal Relations* (Lund University 2010) 15, 16, 27.

4 Elizabeth Fisher, Pasky Pascual and Wendy Wagner, ‘Rethinking Judicial Review of Expert Agencies’ (2015) 93 Tex L Rev 1681, 1716; Thomas O McGarity and Wendy Elizabeth Wagner, *Bending Science: How Special Interests Corrupt Public Health Research* (HUP 2008) 2.

5 Maria Lee and others, ‘Techniques of Knowing in Administration: Co-production, Models, and Conservation Law’ (2018) 45(3) J Law Soc 427, 427.

6 Tiina Paloniitty, *The (In)Compatibility Between Adaptive Management and Law: Regulating Agricultural Runoff in the EU* (Juvenes Print 2018) 5. The judiciary has been considered as an actor in the decision-making process also in Emma Lees, ‘Allocation of Decision-Making Power under the Habitats Directive’ (2016) 28(2) JEL 191.

7 Models producing imprecise predictions are also valuable, and can even be consistently preferable to more precise ones, Alkistis Elliott-Graves, ‘The Value of Imprecise Prediction’ (2020) 12(4) Philos Theor Pract Biol 1, 8, 14.

8 The legal mechanisms are analysed in detail in Section 5.2; Section 2 explains models as scientific tools that address uncertainty, and Section 4.4 examines a case coupling the scientific and legal mechanisms. See respectively texts to n 168, n 19 and n 141.

9 Elizabeth Fisher, Pasky Pascual and Wendy Wagner, ‘Understanding Environmental Models in Their Legal and Regulatory Context’ (2010) 22(2) JEL 251, 254.

and remarkable precision'.¹⁰ Perhaps unsurprisingly, models have caused considerable challenges for regulators and, eventually, the courts.¹¹ Our fillip is accountability: the danger of modelling lies in rendering normative decisions as technical or scientific conclusions, and thus hiding value decisions (on uncertainties) under a veil of science.¹² Modelling practice is an inferential process: modellers make choices with normative impacts, and those decisions can be so greatly embedded in the 'warp and weft' of a model's output that they remain hidden when the substance matter is dealt with in court.¹³ In other words, the scientific process entails mechanisms for addressing uncertainties, but the legal sphere may not always be aware of the assessments and decisions, not to mention their implications for the outcome.

Our example, Finland, is a fruitful jurisdiction for studies on the science and law interface for various reasons. In Finnish administrative courts, investigation is inquisitorial and active and the court is equipped with in-house scientific and technical expertise, the 'expert judges'. The process is also reformatory, allowing the shaping of the planned project and the permit conditions during court review. The understanding of *trias politica* adopted in Finland vests the administrative courts with a broad scope of review—among the widest in Europe but not the widest possible.¹⁴ We have narrowed our investigation down to models in waters-related matters—not only because those are abundant in a land of 5,123 groundwater basins, 4,617 lake water bodies and 1,913 river water bodies—but also because we anticipate that the theme might be most fruitful in cases relevant to the implementation of the EU Water Framework Directive (WFD) and its daughter directive, the Groundwater Directive (GWD).¹⁵ The WFD has established a realm in which questions on the

10 Wendy Wagner, Elizabeth Fisher and Pasky Pascual, 'Misunderstanding Models in Environmental and Public Health Regulation' (2010) 18 NYU Envtl LJ 293, 294.

11 *ibid* 296 fn 11; Pasky Pascual, Wendy Wagner and Elizabeth Fisher, 'Making Method Visible: Improving the Quality of Science-based Regulation' (2012) 2 Mich J Envtl Admin L 429, 433; Emily Hammond Meazell, 'Super Deference, the Science Obsession, and Judicial Review as Translation of Agency Science' (2011) Mich Law Rev 733.

12 Pascual, Wagner and Fisher, *ibid* 434. As Käkönen and Hirsch note, '... technical rendering refers, importantly, to a scientized rationality, which hides politics and depoliticizes [development] decisions' in Mira Käkönen and Philip Hirsch, 'The Anti-politics of Mekong Knowledge Production' in François Molle, Tira Foran and Mira Käkönen (eds), *Contested Waterscapes in the Mekong Region: Hydropower, Livelihoods and Governance* (Earthscan 2009) 333, 343.

13 Wagner, Fisher and Pascual (n 10) 308; Fisher, Pascual and Wagner, (n 9) 257.

14 See text to n 57ff for a closer description of the Finnish system, bearing a close resemblance to the Swedish one. Gitanjali Nain Gill, 'Environmental Justice in India: The National Green Tribunal and Expert Members' (2016) 5(1) TEL 175, 187; Patrick Ky, 'Qualifications, Weight of Opinion, Peer Review and Methodology: A Framework for Understanding the Evaluation of Science in Merits Review' (2012) 24(2) JEL 207; Brian J Preston, 'The Judicial Development of the Precautionary Principle' (2018) 35 EPLJ 123.

15 Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy [2000] OJ L327/1 ('WFD'), Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration [2006] OJ 372/19 ('GWD'). The amounts are according to the WFD's classifications that cover lakes larger than 0.5 km² and rivers with basins greater than 100 km². In the National Land Survey of Finland's statistics the country has at least 168,000 lakes or ponds larger than 500 m², Maanmittauslaitos, 'Suomi 57 000–168 000 järven maa' (12 July 2019) <<https://www.maanmittauslaitos.fi/ajankohtaista/suomi-57-000-168-000-jarven-maa>> accessed 15 September 2020.

interface between science and law are customary, the Directive in itself being a legal tool including regulatory strategy models.¹⁶

We examine the legal and scientific mechanisms for addressing model uncertainty and study whether the Supreme Administrative Court of Finland ('the Court', 'the SAC') has succeeded in negotiating a balance between the two. Has the Court correctly understood the extent of the scientific mechanisms? How has the Court reacted to, or used, models in its work? Has the Court identified the iterative nature of the modelling process and managed to address it with the legal mechanisms at its disposal? By asking these questions in only one jurisdiction, we concur with the scholars who emphasise the contingent nature of environmental law and its ubiquitous environmental principles.¹⁷ Indeed, some of our cases demonstrate the elegance with which courts can strike a balance between the precautionary principle, gradually decreasing scientific uncertainty, and the procedural and substantial realities that criss-cross around the matter.¹⁸

This article unfolds as follows. We begin Section 2 by explaining more about the various commitments that surface and groundwater modelling entails, and their consequences for uncertainty assessment. Then we first set the stage by describing aspects of European Union and domestic environmental regulation (Section 3.1) and Finnish administrative procedural law (Section 3.2) that are significant when dealing with science-heavy matters in general and our sample of cases in particular. In Section 4, we analyse 10 rulings in which the Court took a stance on models and the uncertainty of impacts. These 10 cases are divided into two groups. In the first set, the Court discussed the uncertainties of modelling in general (Section 4.1), and in the second group, these general aspects influenced the determination of the authorization's legal perimeters in particular (Section 4.2). Lastly, in Section 5, we discuss the findings. Did the modellers and the Court seem to understand each other? Did the Court manage to take the inferential process into account? We conclude in Section 5.3 by sketching a mutually reinforcing way forward.

2. ASSESSING ENVIRONMENTAL IMPACTS WITH MODELS

As noted above, modelling is an inferential process and the choices taken during modelling make the model's outcomes evaluative in nature.¹⁹ In the following, 'models' refer to aquatic ecosystem models, a subset of mathematical models used in both groundwater and surface water ecosystems. The decisions that the modellers are forced to make include—but are not limited to—choices over competing models, selection of model parameters and the selection of methods to estimate predictive

16 Fisher, Pascual and Wagner (n 9) 256. There is ample research on the challenges encountered or created by the WFD as a science-heavy regulatory instrument, see eg Daniel Hering and others, 'The European Water Framework Directive at the Age of 10: A Critical Review of the Achievements with Recommendations for the Future' (2010) 408(19) *Sci Total Environ* 4007; Henrik Josefsson and Lasse Baaner, 'The Water Framework Directive—A Directive for the Twenty-First Century?' (2011) 23(3) *JEL* 463; Henrik Josefsson, 'Ecological Status as a Legal Construct—Determining its Legal and Ecological Meaning' (2015) 27(2) *JEL* 231.

17 Eloise Scotford, *Environmental Principles and the Evolution of Environmental Law* (Hart 2017) 272, 3, 11; Ole W Pedersen, 'The Contingent Foundations of Environmental Law' (2018) 30 *JEL* 359, 359, 363.

18 See texts to n 141 and n 152.

19 Text to n 13; Fisher, Pascual and Wagner (n 9) 251, 279–82.

uncertainties or risks for cost-benefit analysis, all of which may have normative consequences.²⁰ Whatever the approach or complexity of the model, it should be borne in mind that models are always only simplifications of reality and can never reproduce real-life patterns precisely, thus being inherently uncertain.²¹ The modellers and judges share the same object of interest, they meet at this uncertainty assessment, with both having their own tools for tackling it. The legal mechanisms for negotiating its realities are discussed later in Sections 4 and 5, but before that, let us take a brief look at the modellers' toolbox for addressing the uncertainties.

2.1 The Tricks of the 'Simplifying the Reality' Trade

Environmental models are tools of environmental impact assessment.²² For example, in water governance, models help in assessing the impacts of a planned project on the nearby surface or groundwaters,²³ evaluating the impacts of water withdrawal on the quantity and quality of groundwater,²⁴ and assessing the impacts of nutrient loadings on the ecological status of lakes.²⁵ Models also assist the environmental impact assessment (EIA) process in quantifying the effects of changing the locations or volumes of the planned actions.²⁶ Also, modelling is coupled with various steps of the WFD's processes. Models are part of identification, designing, implementation, and evaluation—all pivotal elements of the WFD's management cycles.²⁷ This is why the WFD has gained a reputation as including regulatory strategy models: models are deeply intertwined to its structure.²⁸ The uncertainty assessments conducted in the scientific and legal processes described below can thus have a cumulative impact and their interdependencies may decrease the detachment of each aspect, when for example gathering of data and choice of models are connected together more closely.²⁹

- 20 Jens Christian Refsgaard and others, 'Uncertainty in the environmental modelling process—a framework and guidance' (2007) 22(11) *Environ Model Softw* 1543. The concern of losing moments of significant decision-making from sight is not only hypothetical, Käkönen and Hirsch (n 12) 343, 338–9.
- 21 RA Letcher and AJ Jakeman, 'Types of Environmental Models' in Catherine M Marquette (ed), *Water and Development: Encyclopedia of life support systems, Volume II* (UNESCO Encyclopedia of Life Support Systems) 131; Fisher, Pascual and Wagner (n 9) 253; National Research Council (NRC), *Models in Environmental Regulatory Decision Making* (National Academies Press, Washington DC 2007) 31.
- 22 AJ Jakeman, RA Letcher and JP Norton, 'Ten Iterative Steps in Development and Evaluation of Environmental Models' (2006) 21 *Environ Model Softw* 602.
- 23 Qinggai Wang and others, 'A Review of Surface Water Quality Models' (2013) 1–7. *Sci World J*, 1; James W Mercer and Charles R Faust, 'Ground-Water Modeling: An Overview' (1980) 18 *Groundwater* 108.
- 24 Hans Jørgen Henriksen and others, 'Assessment of Exploitable Groundwater Resources of Denmark by use of Ensemble Ressource Indicators and Numerical Groundwater-surface Water Model' (2008) 348(1–2) *J Hydrol* 224.
- 25 Niina Kotamäki and others, 'Statistical Dimensioning of Nutrient Loading Reduction—LLR Assessment Tool for Lake Managers' (2015) 56 *Environ Manag* 480.
- 26 EIA is a specific administrative process for impact assessment and location decision, taking place before administrative authorization procedure and regulated with Directive 2011/92/EU of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (codification) [2012] OJ L 026/1 ('EIA Directive'). See text to n 69ff on the role of the EIA in our cases.
- 27 Refsgaard and others (n 20) 1546.
- 28 Fisher, Pascual and Wagner (n 9) 256.
- 29 This is described as the continuum of normativity above at text to n 6.

The complexity, approaches and nature of models vary depending on the purpose of modelling and on the environmental system that is being modelled.³⁰ Hydrological systems are often modelled using deterministic, process-based models that are built on known physical, chemical or biological theories and expressed as multiple mathematical equations of the system components.³¹ Process-based models can predict ecosystem responses in hypothetical situations, which make them useful in impact assessments. However, they are ‘data-needy’, as they require large amounts of empirical data to calibrate the model to local conditions and to verify the model’s performance.³² The other group of models is empirical—statistical models—which are derived entirely from observational data.³³ Statistical models describe relationships and patterns between variables of interest, and they are often simpler than process-based models. However, their predictive capability does not extend outside the range of the observed data.³⁴

2.2 Uncertainty: Sources, Causes and Mechanisms for Addressing it

Modelling complex interrelated system dynamics and projecting the results of policy decisions into the future can be very uncertain.³⁵ Uncertainty can be described as a decision-maker’s lack of knowledge, or lack of confidence, about the different outcomes of the decision.³⁶ Attitudes towards uncertainty can range from total denial to accepting it as an intrinsic part of science,³⁷ but uncertainty can also be so overwhelming that courts have even used it as an excuse to avoid closer scrutiny of the factual matters.³⁸ However, the most common view in environmental governance is that uncertainty is to some extent unavoidable, but it should be quantified by keeping facts and values separated.³⁹ Thus, as debated as the separation of facts and values

30 Letcher and Jakeman (n 21) 2.

31 Gayathri K Devia, BP Ganasri and GS Dwarakish, ‘A Review on Hydrological Models’ (2015) 4 *Aquat Procedia* 1001.

32 BJ Robson, ‘When do Aquatic Systems Models Provide Useful Predictions, What is Changing, and What is Next?’ (2014) 61 *Environ Model Softw* 287, 288.

33 *ibid.*

34 *ibid.* Statistical models are often used in describing eg ecological phenomena for which data availability is often limited and process-based models hard to validate, Letcher and Jakeman (n 21) 2, 4.

35 JC Ascough and others, ‘Future Research Challenges for Incorporation of Uncertainty in Environmental and Ecological Decision-making’ (2008) 219(3) *Ecol Model* 383, 384–5; S Polasky and others, ‘Decision-making Under Great Uncertainty: Environmental Management in an Era of Global Change’ (2011) 26(8) *Trends Ecol Evol* 398–9.

36 Ascough and others (*ibid.*) 387–8; Katja Sigel, Bernd Klauer and Claudia Pahl-Wostl, ‘Conceptualising Uncertainty in Environmental Decision-making: The Example of the EU Water Framework Directive’ (2010) 69(3) *Ecol Econ* 502.

37 J Arjan Wardekker and others, ‘Uncertainty Communication in Environmental Assessments: Views from the Dutch Science-policy Interface’ (2008) 11(7) *Environ Sci Policy* 627, 630.

38 This attitude has been reported eg in Italy, where the administrative courts could also review the substantial side but are reluctant to do so, Roberto Caranta, ‘Still Searching for a Reliable Script: Access to Scientific Knowledge in Environmental Litigation in Italy’ (2018) 27(4) *EEELR* 158, 168.

39 Wardekker and others (n 37); JP Van der Sluijs, ‘Uncertainty as a Monster in the Science-policy Interface: Four Coping Strategies’ (2005) 52 *Water Sci Technol* 87, 90.

may be, for modelling it is the starting point, and in this article we take that as a given.⁴⁰

Model uncertainty stems from several sources.⁴¹ As Refsgaard and others have investigated, already framing the problem, addressing the right spatio-temporal scope and choosing the relevant output variables include decisions that generate uncertainty. Also, defining the system to be modelled—for example, whether to model only the groundwater processes or also include surface water interactions—is a critical decision included in the initial phase of the modelling procedure.⁴² Secondly, model structure uncertainty arises as the modelled system and the processes are simplified.⁴³ Modelling objectives ought to impact the complexity of the model structure and the number of parameters to be estimated since disregarding important aspects can lead to an overly narrow examination of the phenomenon and to increased uncertainty.⁴⁴ Thirdly, uncertainty over the input data—such as local weather conditions and geology—can lead to insufficient model performance and inadequate predictions. Data uncertainty can stem from insufficient and poorly allocated sampling: empirical measurements must be collected frequently enough and over a sufficiently long period. In three of our cases data uncertainty became an issue, making it a legally highly relevant aspect of modelling.⁴⁵ Fourthly, insufficient knowledge of the right parameter values creates uncertainty. As physical and biological parameters—such as hydraulic conductivity or aquifer thickness—change from location to location, poorly selected or insufficiently known values inevitably affect the performance of the model.⁴⁶ Finally, especially complex models suffer from uncertainty originating from the numerical and resolution approximations and other technical aspects of modelling.⁴⁷

Depending on the cause, uncertainty can be divided into two categories.⁴⁸ So-called stochastic (or aleatory) uncertainty relates to variability and randomness, which are inherent in natural systems.⁴⁹ For example, unpredictable weather conditions cause stochastic uncertainty. This type of uncertainty cannot be reduced, but it can be characterised and quantified, and thus communicated to the decision-maker.⁵⁰ On the other hand, epistemic uncertainty stems from imperfect knowledge of the system's behaviour or lack of monitoring data. This type of uncertainty can be

40 Hilary Putnam, *The Collapse of the Fact/Value Dichotomy and other Essays* (HUP 2002); Maksymilian Del Mar, 'Relational Jurisprudence – Vulnerability between Fact and Value' (2012) 2(2) *Law Method* 63.

41 There are even comprehensive lists of the uncertainty sources related to model-based assessment in Refsgaard and others (n 22) 1546–7; L Uusitalo and others, 'An Overview of Methods to Evaluate Uncertainty of Deterministic Models in Decision Support' (2015) 63 *Environ Model Softw* 24, 25.

42 Refsgaard and others (n 20) 1544, 1546.

43 *ibid* 1547–8.

44 *ibid* 1544–5.

45 Cases at texts to n 123, n 129 and n 136.

46 Refsgaard and others (n 20) 1547.

47 *ibid* 1547, 1552. In one of our cases the court embarked on analysing very technical aspects of the model in questions, see text to n 140.

48 Uusitalo and others (n 41) 25. Linguistic uncertainty can be added as the third category, *ibid* 25.

49 *ibid* 25.

50 *ibid* 25–6.

reduced: collecting more data and developing better models creates a more realistic and less uncertain understanding of the phenomenon.⁵¹

As seen in one of the cases we analyse, if these frailties are discovered and analysed only at the highest court of appeal, they can have drastic impacts on the matter: an originally accepted plan can even be completely rejected.⁵² Thus, the tragedy is that, when left unrecognised, the boundary that these and other technical niceties erect may hide decisions with normative impact from the judges' purview.⁵³ In a perfect world, transparent and comprehensive documentation of the modelling process would make the boundary less opaque⁵⁴ and the assessments that models produced would be salient, credible and legitimate to meet the judges' needs⁵⁵—these objectives being, however, at odds with the inherent uncertainties and limitations of models.⁵⁶ Until we come to the perfect world with perfect models, the courts must make do with what they encounter in their case files. But before seeing how the Court has fared in its task, we next explain the procedural and substantial constraints under which our Court operates.

3. THE SUBSTANCE AND PROCEDURE OF THE LEGAL MECHANISMS

3.1 A Very Brief Introduction to EU and Finnish Water Pollution Regulation

To contextualise the cases we analyse in the next section, we explain the relevant EU and Finnish regulations briefly. Two pieces of EU environmental regulation—the WFD and the GWD—are the protagonists in our study and two others—the Habitats Directive and the Environmental Impact Assessment Directive—play supporting roles.⁵⁷ With the WFD, the Union has created a decentralised water management structure that strives for a shared aim, the good status of all Union waters. Waters are listed as water bodies and managed with River Basin Management Plans (RBMPs), assessing their quality in 6-year cycles; the process is meticulously regulated in the WFD's Annexes.⁵⁸ Surface waters have multiple categories that must be assessed to achieve the objective of good status, but for groundwater, only the

51 *ibid* 25–6. See also HM Regan, M Colyvan and MA Burgman, 'A Taxonomy and Treatment of Uncertainty for Ecology and Conservation Biology' (2002) 12 *Ecol Appl* 618.

52 This, then again, can—rightfully so—cause sentiment of flimsical decisions or generate questions on whether the matter should have been remitted to the first instance for reassessment of facts; see text to n 90.

53 Text to n 6.

54 P Schmolke and others, 'Ecological Models Supporting Environmental Decision-Making: A Strategy for the Future' (2010) 25 *Trends Ecol Evol* 479, 482; N Crout and others, 'Good Modelling Practice' (2008) US Environmental Protection Agency Papers 73.

55 David W Cash and others, 'Knowledge syStems for Sustainable Development' (2003) 100(14) *Proc Natl Acad Sci* 8086.

56 In the same ideal world, decision-makers and stakeholders would be included in model development, resulting in more trust in the model and efficient knowledge exchange between modellers and other participants, Jakeman, Letcher and Norton (n 22). In other words there should be public participation during the modelling process.

57 The latter two are studied here only as implemented in Finland. Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [1992] OJ L 206/7 ('The Habitats Directive') and the EIA Directive.

58 Especially the WFD Annex V; Andrea M Keessen and others, 'European River Basin Districts: Are they Swimming in the Same Implementation Pool?' (2010) *JEL* 22(2) 197.

quantitative and chemical statuses are assessed.⁵⁹ The normativity of the good status objective and its significance to individual undertakings was long debated, but in 2015 the CJEU resolved the matter in its landmark *Weser* ruling.⁶⁰ From then on, the WFD has encompassed two legal norms: the non-deterioration principle and the good status objective, both of which also bind individual authorizations.⁶¹

During the drafting of the WFD, the legislator could not reach agreement on the particular provisions on groundwater chemical status, thus, it warranted a separated directive on pollution—as a ‘daughter directive’, the GWD complements the WFD.⁶² Since 2006, the GWD has represented a mature version of groundwater management in its focus on chemical and quantitative statuses, instead of merely revolving around needs for water abstraction.⁶³ In the spirit of the WFD’s ‘good status’ objective, the deterioration of groundwater quality must be identified and ascending detrimental tendencies reversed.⁶⁴ Natural variability continues to be a challenge in establishing EU-wide quality standards for most pollutants, so an analytical framework steers monitoring and assessment.⁶⁵ Implementation in the Member States builds on their pre-existing water management—coupling the GWD with a strong history of groundwater management has resulted in, for example, development of 3D models of groundwater bodies supporting the water management.⁶⁶

Regarding the Finnish implementation, the Finnish legislation has long included a strict prohibition against groundwater pollution with no exemptions, being thus more rigorous than the minimum level set in the Union regulation and one of three total bans in Finnish environmental legislation.⁶⁷ The strict prohibition was

59 Respectively, the WFD Annex V, 1.1 and 1.2 and the WFD Annex V, 2.1.2 and 2.3.2.

60 Case C-461/13 *Bund v Germany* [2015] ECR I-433 (‘*Weser* case’).

61 HFMW van Rijswijk and Chris W Backes, ‘Ground Breaking Landmark Case on Environmental Quality Standards’ (2015) 12 JEELP 363; Tiina Paloniitty, ‘The *Weser* Case: Case C-461/13 BUND V GERMANY’ (2016) 28(1) JEL 151, 152; Johanna Söderasp and Maria Pettersson, ‘Before and after the *Weser* Case: Legal Application of the Water Framework Directive Environmental Objectives in Sweden’ (2019) 31(2) JEL 265.

62 Defining quantitative groundwater status was not similarly challenging. WFD art 17; Philippe Quevauviller, ‘From the 1996 Groundwater Action Programme to the 2006 Groundwater Directive—What Have We Done, What Have We Learnt, What Is the Way Ahead?’ (2008) *J Environ Monit* (10)4 408, 411.

63 L De Stefano and others, ‘Easier said Than Done? The Establishment of Baseline Groundwater Conditions for the Implementation of the Water Framework Directive in Spain’ (2013) 27(7) *Water Resour Manage* 2691, 2697. The GWD has also faced fierce criticism as probably not having any significant operational impact, Wojciech Rejman, ‘EU Water Framework Directive versus Real Needs of Groundwater Management’ (2007) 21(8) *Water Resour Manage* 1363.

64 GWD art 5 and Annex IV.

65 ‘DPSIR’ or Driver, Pressure, State, Impact, Response Framework, European Commission, Analysis of Pressures and Impacts—Guidance Document No 3 (2003). Nitrates and pesticides are regulated with quality standards, GWD Annex I.

66 Lisbeth Flindt Jørgensen, Karen G Villholth and Jens Christian Refsgaard, ‘Groundwater Management and Protection in Denmark: A Review of Pre-conditions, Advances and Challenges’ (2017) 33(6) *Int J Water Resour Dev* 868, 879.

67 Other total bans forbid polluting soil or sea. The GWD settles for ‘preventing or limiting’ pollution, the GWD art 6. Environmental Protection Act (‘EPA’, ympäristönsuojelulaki 527/2014) 17 §. Minimum harmonisation, common in legal drafting of the EU environmental law, allows Member States to exceed the agreed levels of environmental protection; the theme is thoroughly studied in Lorenzo Squintani, *Beyond Minimum Harmonisation: Gold-Plating and Green-Plating of European Environmental Law* (CUP 2019).

discussed in one of our cases; it turned out that 'strict' does not equal with scientific certainty of no forbidden impacts taking place. Despite of its central role in the EU groundwater governance, in none of the cases we analysed was the GWD even mentioned. We assume that this was due to the established status of the strict prohibition and the reality in which the legal norms are part of the 'parent directive', the WFD.⁶⁸

Otherwise, the Finnish Environmental Protection Act (EPA) currently encompasses all regulation on environmental pollution.⁶⁹ The EPA vests the authorities with discretionary powers to define the closer contents of environmental permits.⁷⁰ The act implements the Industrial Emissions Directive, thus revolving around the concept of (significant) 'pollution', being harmful environmental impact caused by human activity.⁷¹ The starting point of the Finnish EPA is that the applicant is entitled to approval as long as the permit conditions are such that the (threat of) significant pollution is prevented.⁷² Thus, the certainty of estimated impacts is pivotal: there are legal grounds to reject the plan only when the proposed plan cannot be shaped so that the forbidden impacts become unlikely.⁷³ Sustainable development is mentioned as a rationale of the EPA. However, the provisions on permit consideration constrain the Court's 'review of legality' to 'significant pollution', excluding broader considerations on sustainability.⁷⁴

Another act relevant to our cases is the Water Act, which regulates water construction such as artificial groundwater plants.⁷⁵ Importantly, the Water Act does not share the objective of environmental protection, nor advancing sustainable development: the Water Act is primarily about weighing and balancing the various interests at stake, environmental good being only one of them.⁷⁶ The EPA and the Water Act both referred to the RBMPs as material that must be 'taken into account' in decision-making, not constituting legal provision on which authorizations could be based. By referring to the content of the RBMPs, the provisions dispensed with direct references to the good status objective or the non-deterioration principle, being an original implementation solution—and in apparent conflict with the post-Weserian WFD.⁷⁷

68 Text to n 115. 'Strict' does neither mean forbid of all impacts: only impacts causing pollution are prohibited, Erkki J Hollo, *Vesioikeus (Water Law)* (Edita 2014) 420–1. See also text to n 99.

69 Earlier the Water Act (vesilaki 587/2011) included provisions on water pollution.

70 EPA s 48.2.

71 EPA ss 1 and 2; Directive 2010/75/EU of 24 November 2010 on industrial emissions (integrated pollution prevention and control) [2010] OJ L 334/17; Elizabeth Fisher, Bettina Lange and Eloise Scotford, *Environmental Law: Text, Cases & Materials* (2nd edn, OUP 2019) 419–20, 430–33.

72 EPA s 49.1 point 2); Ari Ekroos and others, *Ympäristöoikeuden pääpiirteet (Main Features of Environmental Law)* (3rd edn, Sanoma Pro 2013) 562.

73 Reformatory process is explained at text to n 90.

74 EPA s 1.

75 Water Act 3:3. In matters requiring both permits, both permit considerations must be conducted independently even when the processes are integrated, EPA s 47, Water Act 11:12.

76 Water Act 3:4; Erkki J Hollo, Pekka Vihervuori and Kari Kuusiniemi, 'Environmental Law and Administrative Courts in Finland' (2010) 51(3) J Ct Innovation 51, 52–3; Pekka Vihervuori, 'Private and Public Ownership of Water Areas—Structures and Implications of the Finnish Model' in Erkki J Hollo (ed), *Water Resources Management and the Law* (EE 2017) 98.

77 Aulis Aarnio, *The Rational as Reasonable: A Treatise on Legal Justification* (Reidel cop 1987) 89; Andrea M Keessen and others, 'European River Basin Districts: Are They Swimming in the Same Implementation Pool?' (2010) 22(2) JEL 197; text to n 127.

Some of our cases dealt with Natura 2000, the Union-wide nature conservation network that requires the prohibition of activities outside the protected area if they endanger protected values.⁷⁸ As appropriate, the Finnish Nature Conservation Act section 65 requires the assessment of all such environmental impacts, and these are also considered when deciding on an authorisation.⁷⁹ In Finland the Natura 2000 impact assessment is integrated into formal EIA.⁸⁰ When in matters dealing with the EPA only ‘significant pollution’ is a legitimate reason to reject a project, the broader social or structural impacts analysed in an EIA cannot be taken into account.⁸¹

3.2 Procedural and Practical Realities Enabling Extensive Factual Review in Finland

After this rough description of the substantial context, we sum up the three reasons why the Finnish administrative-procedural system is fruitful terrain for the present study.⁸² Firstly, regarding the intensity of review, even though the country follows the continental pattern of examining only the legality of cases, that legality review is understood broadly: within the limits of the appeal, the scope of courts’ review is similar to that of the administrative authority.⁸³ Here the Finnish judicial review is reminiscent of the German system—but because of the other two aspects, the Finnish courts have been evaluated as conducting broader reviews than their German counterparts.⁸⁴

Secondly, when dealing with matters involving the EPA or Water Act, the court chamber consists not only of lawyer judges but also expert judges, who do not have formal legal education but hold a technical or science degree.⁸⁵ In this multi-professional setting the courts should have a heterogeneous understanding of the

78 The Habitats Directive art 6(3). The decision-making process in the Habitats Directive and its relations with the EIA process are explained in Lees (n 6) 193–5.

79 Finnish Nature Conservation Act s 65.2 and s 65.4 (‘NCA’, luonnonsuojelulaki 255/2017); EPA s 48.3 , Water Act 1:2.

80 In cases when assessment according to the implementing legislation of the EIA Directive takes place, NCA s 65.2; Ismo Pölönen, ‘Mikä riittää vai riittääkö mikään? Natura-arvioinnille asetetut vaatimukset unionin tuomioistuimen linjan mukaan (What Is Enough? The Requirements of the Natura 2000 Assessments in the CJEU Case Law)’ (2019) 2 Ympäristöjuridiikka 10, 15, 17.

81 Ekroos and others (n 72) 277; Pölönen, *ibid* 24.

82 The Finnish system was originally a Swedish one, Pekka Vihervuori, ‘Förvaltningsprocessuella likheter och olikheter mellan Sverige och Finland – axplock fran historia och nutid’ in Thomas Bull, Henrik Jermsten and Sara Uhrbom (eds), *Vänbok till Mats Melin* (Iustus Förlag 2018) 451; Jan Darpö, ‘Environmental Justice through Environmental Courts? Lessons Learned from the Swedish Experience’ in Jonas Ebbesson and Phoebe Okowa (eds), *Environmental Law and Justice in Context* (CUP 2019) 176.

83 Pekka Vihervuori, ‘Totuudesta hallintolainkäytössä (Truth in the Judicial Review of Administrative Action)’ in Risto Nuolima, Pekka Vihervuori and Hannele Klemettinen (eds), *Juhlajulkaisu Pekka Hallberg 1944–12/6–2004* (Suomalainen lakimiesyhdistys 2004) 496.

84 Tiina Paloniitty and Mariolina Eliantonio, ‘Scientific Knowledge in Environmental Judicial Review: Safeguarding Effective Judicial Protection in the EU Member States?’ (2018) 27(4) *EEELR* 108, 111.

85 The expert judge system is thoroughly explained in Hanna Nieminen-Finne, *Asiantuntija tuomarina. Tekniikan ja luonnontieteiden alan hallinto-oikeustuomarit ympäristönsuojeluasioissa* (Expert as a Judge: Technical and Scientific Judges in Environmental Matters) (SLY 2020); also Tiina Paloniitty and Sinikka Kangasmaa, ‘Securing Scientific Understanding: Expert Judges in Finnish Environmental Administrative Judicial Review’ (2018) 27(4) *EEELR* 125.

object of their inquiry.⁸⁶ The expert judges participate in developing the court's understanding of both the legal and scientific sides of the case, and reconciling the epistemological gap between sciences.⁸⁷ Unfortunately, only matters dealing with the EPA or Water Act benefit from expert judges' review. At the level of first appeal, these cases are centralised in one of the administrative courts ('the Vaasa court'), employing expert judges.⁸⁸ Also in the Supreme Administrative Court only cases dealing with the two acts benefit from the expert judge's scrutiny.⁸⁹

Thirdly, administrative courts are allowed not only to annul or injunct the case but also amend the permit and its conditions.⁹⁰ However, they are not allowed to replace the authority's decision: should the case call for total reconsideration of the matter, the courts must remit the case to the first instance administrative authority.⁹¹ This obligation is linked with the inquisitorial and investigative approach in use, known as the *ex officio* principle: the court must actively investigate the matter and establish that they have adequate information to make a ruling.⁹² The outcome of this comprehensive investigation is not referred to as 'evidence'—this concept is reserved for the general courts⁹³—but the factual matters are discussed as pertaining to the adequate investigation of the matter, emphasising the objectives of impartiality, proportionality and equality of judicial review.⁹⁴ We apply this linguistic choice in this article.

4. WATER MODELS IN TEN EXAMINATIONS

As mentioned above, we seek to examine if scientific models had been discussed in the Court's case law and, if so, how the Court had used, reacted to, or argued about environmental models. To answer these two questions, we adopted a systematic approach and searched the open online repository of the SAC's rulings that includes decisions from 1980 on.⁹⁵ Firstly, we searched the index words 'model' and 'water' and their variations, obtaining 165 results.⁹⁶ After reading through them, 42 appeared relevant to the questions we had posed. In nine of those 42 rulings, the Court

86 Paloniitty and Eliantonio (n 84) 111–12.

87 Wahlberg (n 3) 13, 181–82.

88 eg cases dealing with nature conservation or land use and building only are deliberated without the expert judges, in Paloniitty and Kangasmaa (n 85) 134, 138.

89 As of 2018 leave to appeal has been demanded when taking matters to the SAC (Administrative Judicial Procedure Act s 107 ('AJPA'); laki oikeudenkäynnistä hallintoasioissa 808/2019); Paloniitty and Kangasmaa (n 85) 133 fn 62.

90 Olli Mäenpää, *Hallintoprosessioikeus (Judicial Procedure in Administrative Courts)* (2nd edn, WSOYpro 2007) 502.

91 AJPA s 81 lists the possible actions for the court; replacing the original decision not included.

92 AJPA s 37; Mäenpää (n 90) 372.

93 Vihervuori (n 83) 496; Olli Mäenpää, 'Judiciary v. Executive: Judicial Review and the Exercise of Executive Power' (2017) 2–4 JFT 242, 242–43; Mikael Hildén, 'Opportunities and Challenges in Providing and Using Scientific Knowledge in Environmental Appeal Cases in Finland' in Kari Kuusiniemi, Outi Suviranta and Veli-Pekka Viljanen (eds), *Juhlajulkaisu Pekka Vihervuori 1950–25/8–2020* (SLY 2020) fn 14 and text to it.

94 AJPA s 37.2.

95 The repository we used is Finlex, <<https://www.finlex.fi/fi/>> accessed 15 September 2020. The site has also an English version that, however, covers only the legislation, not the courts' rulings.

96 The first search was conducted on 25 October 2018; the complementary search on 31 October 2018. Our temporal period included all cases in the online repository up until these dates.

commented on, or analysed, models in detail, or they were otherwise evaluated as fruitful material for the analysis. Later, in fall 2019, we added a tenth case to the analysis: the so-called *Finnpulp* ruling, in which the Court discussed water models at a level of detail previously unseen.⁹⁷ In Section 5 we discuss the significance of these first steps of our case analysis. What does it say that only nine cases out of 207 in total included extensive analysis of the environmental models estimating the environmental impact?

4.1 ‘The Unseen’ and Other Initial Findings

Before embarking on the closer analysis, some preliminary remarks are required. Firstly, the unseen: what we did not find? The oldest case in our search dates back to 2002 but only to 2002, when the repository includes cases from year 1980 on. Models were already prevalent then. How did the Court conceptualise models and their output in the last century? Our informed guess is that, more than telling us anything about a courts’ approach to models, the lack of findings illustrates the change that has taken place in the Court’s reasoning. The discourse on administrative judicial procedure and the work to develop it has been rich since the turn of the century. The court’s impartiality, absence of bipartisan relationships, and the court’s dispute-resolving function have all been debated, as has the constitutional obligation to give reasons.⁹⁸ We assume this development work may have influenced the Court’s practices and led to more thorough reasoning.

Secondly, most of the cases dealt with artificial groundwater plants and other groundwater matters, not surface water models, even though the searches would have enabled us to find both. Our best guess is that due to the straight-forward regulatory situation, groundwater models have gained legal decision-makers’ attention more easily than surface water ones. Regulatory setting of surface waters is much more diverse and complicated, leaving room for legal manoeuvres.⁹⁹ The strict prohibition against groundwater pollution leaves little room for legal debate, immediately moving attention to the impact assessment.¹⁰⁰ Also, illustrating the same enduring determination to protect groundwaters, the nation has a long history of effective groundwater management, data collection, and development of groundwater models.¹⁰¹ As a combination, the openly available data and models have been readily at

97 The *Finnpulp* case (KHO 2019:166, ECLI:FI:KHO:2019:166), at text to n 141.

98 Ann-Mari Pitkäranta, *Näytön arvioinnista tuloveroprosessissa* (Assessment of evidence in income tax procedure) (Edita 2004) 11, 35; Jyrki Virolainen and Petri Martikainen, *Pro & Contra—Tuomion perustelemisen keskeisiä kysymyksiä* (Pro & Contra—Key aspects of justifying a judgement) (Talentum 2003) 129–30; Pekka Hallberg, ‘Tuomioistuinten päätösten perusteleminen (Reasoning in Court Rulings)’ in Pekka Hallberg (ed), *Juhlajulkaisu Aulis Aarnio 1937–14/5–1997* (SLY 1997).

99 Many pieces of regulation are relevant to surface waters; the EPA is only the most important on pollution. The strict prohibition was originally part of Water Act, which otherwise allows all but free balancing of interests, text to n 75ff. The strict prohibition is strikingly different from that.

100 Text to n 69. This consideration builds on the assumption that the courts prefer dealing with the legal questions and are more inclined to move to factual questions when room for legal interpretation is limited. This perception may well be mistaken.

101 The strict prohibition was taken to the Water Act in 1962. Models for all types of groundwater aquifers had already been made in the 1990s.

hand for those impact assessment deliberations that the legal context has made critical.

Thirdly, regardless of the use of expert judges or the broad scope of their review, the SAC—or the administrative court before it—have evaluated models only in a very finite number of cases.¹⁰² In only three of the cases we analysed did the SAC discuss in detail the implications that models had on the assessment of the environmental impacts of the proposed plan, conceptualising them as uncertainty, risk, level of adequate information etc. These cases are the *Roine Case*, the *Alholmens Kraft Case* and the *Finnpulp case*.¹⁰³ Naturally, we cannot evaluate whether the rest of the cases would have benefitted from such a thorough deliberation, or whether models were left undiscussed because such analysis was not necessary. It is, however, noteworthy that, even though Finnish administrative courts have the constitutional, procedural and practical ability to embark on the factual considerations, modelling or model uncertainties were found crucial only in such a limited number of cases.

These general remarks and reservations aside, the rulings did teach valuable lessons from the courts' dealings with models. Let us now discuss the rulings in two settings: first those addressing the uncertainty dilemma, and then those focusing on the legal mechanisms to tackle uncertainties.

4.2 Court's Concepts: Diverse Degrees of Uncertainty

The Court's general comprehension of scientific uncertainty was at the heart of the second-newest of the cases, the *Roine Case*.¹⁰⁴ This case concerned an artificial groundwater venture that might have affected a nearby Natura 2000 site. The decision followed closely the legal norm that the Natura 2000 sites are protected from also indirect impacts, that is from activities taking place outside of the area's boundaries.¹⁰⁵ The conservation values of the site were closely linked with the site's groundwater levels, and thus of concern when authorising undertakings outside the area.¹⁰⁶ The Vaasa court discussed the role of the precautionary principle and scientific uncertainty, noting that neither was a reason as such to disallow the venture: they only obliged the authority to establish such permit conditions that would curb the harmful impact.¹⁰⁷ The Vaasa court's stance on uncertainty was, however, stricter than this: it stated that evaluations and statements must *remove* the uncertainty, and only then could the permit conditions counteract the harmful impacts.¹⁰⁸ This notion is naturally scientifically incorrect, and should be understood only in its context. The Vaasa court may have referred to the process order where the proponent provides the adequate investigation and only then the court decides on the matter; most likely the court implied that the investigation was not yet sufficient for a decision to take

102 As appropriate, when even courts with much narrower scopes of review have evaluated models' suitability. Not even the very high threshold of UK *Wednesbury* irrationality has prevented judges from finding models at the core of legal disputes, Fisher and others (n 9) 259–62.

103 Respectively texts to n 104, n 120 and n 141.

104 SAC 2018:121 ('*The Roine Case*' KHO 2018:121 ECLI:FI:KHO:2018:121).

105 The Habitat's Directive 6(2) art.

106 On the Finnish Natura 2000 implementation, see text to n 78.

107 *The Roine Case*; Sigel and others (n 36).

108 *The Roine Case*, Summary of the administrative court's conclusions.

place.¹⁰⁹ However, this can also be taken as an example of why modellers ought to better articulate and communicate their work.¹¹⁰

In appealing the case to the SAC, some parties involved complained about the Vaasa court's reasoning on the certainty of the knowledge models produce. Without specifically referring to these complaints,¹¹¹ the Court discussed scientific uncertainty by referring to the guidelines set by the Court of Justice of the European Union (CJEU).¹¹² The Court noted how the scientific assessments were too uncertain on the undertaking's detrimental consequences surpassing the acceptable threshold, and hence, the permit should not have been granted in the first place.¹¹³ This was the case in one-third of the plant's planned area, at its edges. Because of this considerable scientific uncertainty, the administration was found correct in not allowing the undertaking to extend to those edges. Since the same uncertainties did not apply to the other two-thirds of the area, the SAC upheld the Vaasa court's ruling in that regard.¹¹⁴

The characteristics of the model explain why the Court decided to restrict the plant's area. The groundwater model estimated the currents of water in the ground and, as typical of such models, it was more uncertain at the edges of the area than in its centre. The Vaasa court had not referred to these differences in uncertainty, but the SAC found them crucial and justified its reasoning by pointing to the differences. Another key reason was that the area in question was an especially small and sensitive part of the Natura 2000 site. Production in the area might have brought about a forbidden detrimental impact to the protected conservation values, especially with regard to the size of the protected area.¹¹⁵

An earlier ruling, *the Turku Case*, on artificial groundwater undertakings, also discussed the uncertainties of models.¹¹⁶ The administrative court concluded that the development's long-term impacts could not be modelled with adequate certainty. In this ruling the court's obligation to examine the matter was coupled with the strict prohibition of groundwater pollution.¹¹⁷ However, in this case the SAC did not find that model uncertainties would have evoked the strict prohibition but stated that closer monitoring obligations were enough to curb the risk of groundwater pollution. Thus, the undertaking was permitted with amended permit conditions on monitoring. Importantly, the Court found that the inherent uncertainty of models does not always automatically lead to operationalising the strict prohibitions—'strict prohibition' does not require that there should be full scientific certainty of no detrimental impacts taking place. The *Turku Case* offers us an interesting example of the

109 See text to n 92.

110 Text to n 168.

111 *The Roine Case*, Dealings in the SAC.

112 The SAC referred to the CJEU rulings C-441/17 *Commission v Poland (Forêt de Białowieża)* [2018] ECLI:EU:C:2018:255 para 114; C-258/11 *Sweetman and Others* [2013] ECLI:EU:C:2013:220 para 44; and C-387/15 and C-388/15 *Orleans and Others* [2016] ECLI:EU:C:2016:583 para 50.

113 *The Roine Case*, Dealings in the SAC, Chapter 4, subchapter on judicial review.

114 The Vaasa court had remitted the case back to the administrative authority, showing the limits of the reformatory process, *The Roine Case*, Dealings in the SAC, Chapter 4, subchapter on judicial review.

115 *The Roine Case*, Dealings in the SAC, Chapter 4, subchapter on judicial review.

116 The SAC 2008:58 ('*The Turku Case*' KHO 2008:58 ECLI:FIN:KHO:2008:58).

117 Texts to n 69 and n 100.

mechanisms of environmental uncertainty adjudication. Monitoring becomes all more central when uncertain matters, tilting towards acceptable, can be allowed to proceed with advanced monitoring obligations.¹¹⁸ The case also left us pondering whether better argumentation on the model uncertainties and risks involved might have aided the legal side in their assessments, as discussed further in the conclusions.¹¹⁹

A third case, also dealing with the strict prohibition of groundwater pollution, went to the core of the reliability of models and the information they produce, and invoked an interesting ruling on the relation between adequate investigation and administrative authorizations. The substance matter of the *Alholmens Kraft Case* was the impact of a waste burning plant's ash utilization: the plan was to use the ash in landfill cover structures.¹²⁰ The administrative court had not allowed the plan to proceed. In this case, the SAC specifically commented on the administrative court's reasoning on modelling uncertainty. It summed up its stance by saying that:

When assessing the credibility of modelling, the administrative court has not taken into account modelling's initial conditions and method of implementation. Modelling can never be a full equivalent of actual circumstances.¹²¹

The SAC stated that the model in the case was deliberately built to ensure that no prohibited harm to health or environment was caused. To serve this purpose, the model was written to estimate the worst-case scenario. In the SAC's reasoning, the fact that a model can never replicate the reality, but only approximate it, resulted in a need to pay closer attention to the assumptions in the model itself. Due to the initial choices of this model, it produced adequate information on the project's prospective outcome, contrary to the administrative court's stance (finding the project's risks were not fully disclosed). This notwithstanding, the SAC withheld the administrative court's ruling: it was not certain that the planned project did not cause prohibited environmental harm.¹²² Thus, the instances differed in reasoning but coincided in outcome. In the SAC's understanding, the model produced adequate information on the planned project's impacts, but as such forbidden pollution of groundwater could have resulted.¹²³

118 The strict prohibition does not mean ban of all impacts and as such places the risks to the operator, if they start an activity with uncertain impacts. In this case the responsibility was allocated to the operator—and the administration surveilling the monitoring; Hollo (n 68) 420.

119 Text to n 152.

120 SAC 2005:23 ('*Alholmens Kraft Case*' KHO 2005:23 ECLI:FIN:KHO:2005:23).

121 *Alholmens Kraft Case*, Dealings in the SAC; translation by the authors. 'Mallinnuksen luotettavuutta arvioidessaan hallinto-oikeus ei ole ottanut huomioon mallinnuksen lähtökohtaa ja toteutustapaa. Mallinnus ei koskaan voi vastata täysin todellisia olosuhteita.'

122 The close content in both instances was about the dumping ground's structures and whether or not to build them from waste ash.

123 Interestingly, the administrative court's ruling had a dissenting opinion from the expert judge. According to the dissent, the proposed project fulfilled the Best Available Technique requirements and permit should have been granted, the Vaasa Administrative Court 9.6.2003, as referred to by the SAC.

4.3 Legal Mechanisms for Dealing with the Uncertainties

In the three cases discussed above, the SAC reviewed whether the matter had been investigated thoroughly enough, and whether the uncertain estimates produced by models constituted adequate information. The next group of rulings continues from these considerations to the specific legal mechanisms with which the Court addressed the various degrees of uncertainty. What legal tools does the Finnish legal system offer, and how has the Court used them?

The *Lakeuden Vesi Case* offered one answer to the question—fixed permit duration—but the ruling also shed light on how the SAC combines different sources of information in its decision-making to fill the gaps that models can leave.¹²⁴ The case was about a water abstraction plant whose environmental impacts on the ground-water and surface water levels had been modelled. The model drew on information gained from experimental pumpings that had been made in a relatively short time span. It was estimated that the information available on the planned undertaking's long-term consequences was especially uncertain.¹²⁵ In considering these long-term impacts, the SAC referred to the RBMPs, and the *Weser* ruling on the normativity of the environmental objectives in the RBMPs.¹²⁶ The *Lakeuden Vesi Case* is among the first in which the Court introduced its interpretation of the post-Weserian WFD: endangering the achievement of objectives is relevant.¹²⁷

Since the outcome of the model was especially uncertain in the longer term, the SAC turned to the RBMPs, source of information dedicated to the needs of long-term planning. In this case the proposed plan did not endanger the achievement of the good status objective and could thus be approved. The SAC continued by stating that, even though the applicant had presented adequate information on the planned project's prospective impacts—in other words, the model sufficed in general—there were uncertainties regarding the long-term combined impacts of the planned project and other activities in the area. This justified authorising the plant for a fixed term of 10 years.¹²⁸ In the SAC's reading, the post-Weserian WFD complements the Finnish environmental legal system well, elegantly bringing together the needs of granting permits despite uncertainty and gradually increasing scientific knowledge. We discuss these adaptive traits in the concluding section.¹²⁹

The *Salo II Case* offered a variation to this solution of fixed permit duration.¹³⁰ The substance matter was also water abstraction, but in this case the appellants criticised the groundwater model as being of poor quality. The SAC largely maintained the administrative court's solution, which was to oblige the appellant to renew

124 SAC 13.4.2017 no: 1711 ('*Lakeuden Vesi Case*' KHO 13.4.2017 t. 1711).

125 *Lakeuden Vesi Case*, Dealings in the administrative court.

126 See text to n 58.

127 As noted above at text to n 77, it was left to the SAC to pronounce on the impact of the *Weser* ruling on the domestic legal order. That is unfortunate in a statutory legal system—or in any system, for as Fisher puts it, 'a rule of the common law does not necessarily have the same shape or structure as a rule enacted by a legislature' in Douglas Fisher, *Legal Reasoning in Environmental Law: A Study of Structure, Form and Language* (Edward Elgar Publishing 2013) 36.

128 The SAC followed a similar line of thought in spring 2018 in a sequence of aquaculture cases, eg SAC 26.4.2018 No 1952 (KHO 26.4.2018 t. 1952), SAC 26.4.2018 No 1953 (KHO 26.4.2018 t. 1953).

129 See text to n 152.

130 SAC 26.2.2016 No 605 ('*The Salo II Case*' KHO 26.2.2016 t. 605).

the model during the plant's first term of use and present then the new model. The case revolved around Natura 2000 sites and the abstraction's impact on their protection. The administrative court assessed the groundwater model used as being overly positive: it had been created approximately 15 years earlier and drew on test pumpings conducted over a relatively short period of time in a vast area of complex geography. Also, because the groundwater levels were higher than normal during the test pumpings, the conclusions drawn from them were too optimistic. The administrative court continued that, since more information was available and up-to-date models would help to assess the amounts of water abstraction and hydrogeographical conditions, an updated model was needed for the current situation.¹³¹ This did not, however, result in the planned project being rejected; it was authorised for a very short time (for a few years), resembling a permit for testing purposes—for that end, the matter had been investigated thoroughly enough.¹³²

When the SAC upheld the administrative court's ruling in the *Salo II* Case, it justified its stance with two arguments. Firstly, the plant was authorised for a very short time, and secondly, the operator was obliged to monitor the plant's impacts on the groundwater levels.¹³³ The monitoring obligation was also part of the legal toolkit in the matter's first round, in the *Salo I* Case.¹³⁴ Uncertainties in groundwater models had already been openly debated earlier during the process, as well as in the SAC. Ruling on sufficient investigation was also the reason to take the decision to the SAC's annals.¹³⁵ In the summary the Court stated that, because the investigation was insufficient, the permit conditions had to be amended before an abstraction permit could be granted. The Court amended the conditions on in multiple ways: it tightened the monitoring obligation, significantly lowered the abstraction amount allowed, made the permit temporary, and added other permit conditions constraining the plant from what had been planned.¹³⁶

The *Laukaa* Case¹³⁷ also discussed groundwater quality, but in the context of land excavation; it was claimed that land excavation activities had caused the productivity of the nearby artificial groundwater plant to fall. Here the SAC operated with the strictest possible legal tool, that of rejecting the proposal. During the proceedings in the SAC the appellant criticised the administrative authority's model as inadequate: the model had been built on measurements performed over the course of only one year. In the appellant's opinion, such a model could not constitute adequate review of their plant's impacts and the Court should, on the contrary, rely on their assessment of the plant's environmental impacts. The SAC, however, upheld the administrative court's ruling, which had prohibited the appellant's activities. According

131 *The Salo II Case*, Dealings in the administrative court, Water flow model.

132 *The Salo II Case*, Dealings in the administrative court, sufficiency of evidence. In this part the administrative court's argumentation momentarily lapsed. The court laconically declared that 'The Administrative Court states that knowledge of water abstraction's consequences can be obtained only by abstracting water.' (In Finnish, 'Hallinto-oikeus toteaa, että vedenoton vaikutuksista saadaan selvitystä vain ottamalla vettä').

133 *The Salo II Case*, Dealings in the SAC, conclusions.

134 SAC 2005:57 ('*The Salo I Case*' KHO 2005:57 ECLI:FIN:KHO:2005:57).

135 See n 144 and text to it.

136 *The Salo I Case*, summary.

137 SAC 16.11.2017 No. 5910 (KHO 16.11.2017 t. 5910).

to the favoured argumentation, the appellant's survey comprised individual measurements performed on single days over multiple years, and such information did not qualify as adequate information on the plant's groundwater impacts—especially when the administrative authority's modelling revealed that groundwater flow was from the excavation site towards the plant, strengthening the link between the two undertakings. Thus, in this ruling the courts did not rely on individual measurements performed over multiple years, but preferred the model's output, even if it made use of samples measured over only a single year.¹³⁸

Two of the cases we found concerned models in a highly specialised context not falling into the two categories analysed above—conceptualising uncertainty or choice over legal mechanisms—but exemplify the strategic use of models in litigation. Both cases dealt with one of the nation's most controversial ventures, the Talvivaara/Terrafame mine. The mine has been an abundant source not only of raw materials but also momentous and long-term environmental problems, resulting in multiple judicial proceedings.¹³⁹ In the ruling SAC 2017:75 (*Talvivaara II*), the appellant claimed that the models used by the company were trade secrets and could not be disclosed. Regrettably to the investigative mind, the administrative court or the SAC did not need to take a stance on this fascinating question: the mining company went bankrupt, revealing the information to the bankruptcy trustees and later to the state-run company that succeeded it, Terrafame. Thus, we do not know whether a model could be a trade secret.

Another ruling from the Talvivaara saga discussed the need to revise the model in use. The matter discussed in case SAC 2014:187 (*Talvivaara I*) was important enough to earn the ruling a place in the SAC's annals (yearbook of the most important rulings).¹⁴⁰ The ruling's legal question was on the Finnish EPA's section 62, on the notification process that should be used only in urgent and dire circumstances when the primary mechanism—re-evaluating the environmental permit—is too slow. The appellant claimed that they needed to revise the models before being able to ensure that prohibited water pollution would not happen, and that revision work was why they failed to begin the notification process in time. The SAC did not approve of this logic, retaining the scope of EPA section 62 for emergencies only.

4.4 Binding the Legal and Scientific Assessments Together (with the Weser Case)

The last ruling, we discuss is the *Finnpulp* case, concluded on 19 December 2019 and a landmark ruling in many aspects.¹⁴¹ In the *Finnpulp* case, the Court discussed

138 Sufficient measurement data is a vital part of model performance. Measurements are used to set the boundary and initial conditions, and for model calibration and validation, N Schuwirth and others, 'How to make Ecological Models Useful for Environmental Management' (2019) 411 *Ecol Model* art no 108784, 2–3.

139 The story of the Talvivaara mine began as national pride but continued as conflict when environmental impacts of unprecedented scale and complexity started to emerge, Rauno Sairinen, Heidi Tiainen and Tuija Mononen, 'Talvivaara Mine and Water Pollution: An Analysis of Mining Conflict in Finland' (2017) 4 *Ext Ind Soc* 640, 649.

140 SAC 2014:187 (KHO 2014:187 ECLI:FIN:KHO:2014:187).

141 The SAC 2019:166 ('*The Finnulp Case*' KHO 2019:166, ECLI:FI:KHO:2019:166). The case was considered in a chamber of two expert judges, one with technical and the other with scientific education.

the modeller's inferential process and method extensively and in unprecedented detail. Its decision relied on the factual analysis, which was bound up elegantly with the legal components of the precautionary principle and the concept of 'significant pollution' pivotal in the EPA's regime. Simultaneously, the Court took the opportunity to settle its reading of the *Weser* ruling.¹⁴²

The *Finnpulp* case was about a pulp (or biomass) plant planned in the city of Kuopio in Eastern Finland. The plant attracted the strongest opposition mainly due to its planned site, size and production volume: it would have discharged its waste water into Lake Kallavesi, near where the city extracted its drinking water and had its key recreational area. The first-level approving authorization was taken to the Vaasa court, which, after conducting an on-site inspection, approved the plan but modified the permit conditions. The SAC granted leave to appeal and, while considering its stance, conducted another on-site inspection.¹⁴³ Having both courts inspecting the same site is a sign of the importance of the planned location in this case. To the indignation of the hopeful operator, the SAC decided to annul the permit. The ruling was taken into the annals of the Court, implying its role as a precedent (that is, if one accepts the notion that the Court sets precedents).¹⁴⁴

The *Finnpulp* case is significant in three aspects, all of them resulting from the fact that the *Weser* ruling and the *Finnpulp* ruling are cut from the same cloth: they are both well-reasoned and unequivocal pieces of judicial decision-making. Firstly, the *Finnpulp* case clarified the domestic legal status of whether the norms set in the *Weser* ruling are also to be implemented in Finland: thanks to the loyalty principle and principle of indirect effect in the EU law, they are, regardless of whether the domestic legislator has been unhurried in its actions.¹⁴⁵ Secondly, the Court also elucidated that, in matters dealing with both the EPA and the post-Weserian WFD, three distinct matters must be considered: the permit conditions; the precautionary principle; and the norms established in the *Weser* ruling, ie the non-deterioration principle and the obligation to reach the good status. None of these attenuate each other, nor does passing one threshold equal passing all three. But if an impact breaches the WFD's non-deterioration principle, that impact counts as 'significant pollution' in the EPA's regime (a context where the precautionary principle must be considered).¹⁴⁶ Here the Court corrected the Vaasa court, which had merged the precautionary principle and the non-deterioration principle in its reasoning. The concept of 'pollution' does not inevitably encompass the WFD's norms, but both must

The decision was the result of a vote (5–2) with one technical expert judge and one legally trained judge dissenting.

142 To the extent that a court can; see text to n 126.

143 Requiring leave to appeal is a novelty in Finnish administrative procedure; it has been used in the SAC since 2018. On-site inspections are regulated in the EPA s 197.1, the Water Act 15:4.2 and in the AJPA s 36. On the rarity of on-site inspections, see Paloniitty and Kangasmaa (n 85) 133 fn 60, 135 fn 80.

144 A very concise summary of the vivid discourse on the matter is in Paloniitty and Kangasmaa (n 85) 133 fn 62.

145 Similar argumentation was used before in the *Sierilä Case*, when the Court decided on the same question in the context of the Water Act. The SAC 2017:87 at 4.2.5.5.1 (KHO 2017:87, ECLI:FI:KHO:2017:87); Sara Kymenvaara and others, 'Variations on the same Theme: Environmental Objectives of the Water Framework Directive in Environmental Permitting in the Nordic Countries' (2019) 28(2) RECIEL 197, 203.

146 *Finnpulp case* at 4.2.3; text to n 69.

be assessed separately—and negotiating the precautionary principle is yet another independent legal manoeuvre.¹⁴⁷

The third aspect is the role played by the surface water model. In our 10-case examples, the *Finnpulp* case was the only one in which the Court discussed the niceties of the modeller's inferential process—and, as an outcome, found the model inadequate for its purpose. The ruling is a prime example of the possibilities of the procedural and practical realities in the last instance of court.¹⁴⁸ The coupled hydrodynamic and water quality model was built to estimate the proposed plant's impact on the nearby lake waters. The Court analysed the model extensively, considering not only the known features of the model and its outcome, but also the unknowns. In reflecting on whether the model—originally designed for use in coastal waters—was apposite to the inland lake processes, the Court noted that the (inevitable) technical simplifications in the model were in the numerical solutions of the flow equations and the model grid size. The Court continued by starkly criticising the oxygen modelling and noted its results as the weakest point of the water impact assessments: the model was found overestimating the decomposition rate of organic matter. In its summing up in the legal evaluation, the Court listed factors excluded from the modelling—the combined effect of sulphite, phosphorus, oxygen consumption and heat load—that nonetheless affect the lake's eutrophication development. The legal-factual assessment was holistic: the Court concluded that the combined and long-term water impacts were too uncertain for approval.

The Court implemented the *Weser* ruling in the Finnish legal system along the lines that it had established in its earlier cases: emissions from new projects must not hinder the achievement of the WFD's good status objective.¹⁴⁹ The condition of the recipient water body also played a significant role. Particularly because of eutrophication, the trend in Lake Kallavesi tended towards being of poorer status, justifying a more stringent attitude towards a new, significant and long-term emission source. Major industrial operators do not usually wish to proceed with their plans with temporary permits. This was the case also here: the operator had declined the option of a temporary permit, leaving one legal mechanism to tackle scientific uncertainties unavailable.

Another legal mechanism that might have been the operator's saving grace had deliberately been removed from the legislation in 2015, when a section on regular reviews of permits was deleted from the Finnish EPA.¹⁵⁰ The Court specifically noted that adding a permit condition on regular reviews of permits meant that they lacked an option to revise the permit conditions later, if the currently uncertain emissions were later to stabilise at a certain level. The Court continued by stating that the

147 The Vaasa Court had taken the EPA's 'must be taken into account' reference quite literally: it stated that since they had taken the good status objective into account in their evaluation of the EPA-based pollution, the obligations laid down in the WFD had been fulfilled. The Vaasa Court Decision No: 18/0222/2 given on 21 September 2018 [at 110-1] (Vaasan HaO 21.9.2018 nro 18/0222/2).

148 Text to n 57.

149 Text to n 128.

150 The Government's proposal 423/2015 (HE 423/2015). The mandatory check-up points were removed as an action to streamline the environmental permitting system, with hopes that EPA s 89 on changing the permit would be enacted more often; text to n 177.

still existing clause on specific investigation of a permitted project cannot cover for the absence of regular reviews, which were more holistic in their scope, and that scientific uncertainties at the time of permit consideration cannot be tamed with permit conditions requiring later specific investigations on emissions central to the proposed plant's operation—here the long-term water impacts on Lake Kallavesi.¹⁵¹

5. WHOSE UNCERTAINTIES, WHOSE PRINCIPLES? NEGOTIATING THE BALANCE

5.1 Ten Cases Threading the Continuum of Uncertainty Assessments

According to our sample of cases, the courts have reacted to models in three ways. In the vast majority of the cases, the courts had an uncomplicated relationship with the models. The courts did not extensively discuss them or refer to their specifics—only incidental mentions in reasoning reveal that models were involved. Occasionally, the courts had reason to employ their right to consider also the factual matters. In these rulings, the courts pondered models, their particularities and outcomes, and their implications for the matter at hand. The 10 SAC rulings we discussed above in detail are such: the courts invested time and effort to understand the niceties of the models involved and the challenges that could result from their characteristics. The Court relied on the concept of uncertainty and utilised the legal mechanisms at its disposal in balancing the uncertainty of the proposed project's consequences with the norms and principles constraining the matter. In general, these legal mechanisms are almost identical to the legal mechanisms employed in executing the precautionary principle in the Australian context, exemplifying the adaptive management approach.¹⁵² These adaptive traits are discussed in the closing section.¹⁵³ Of the 206 rulings we originally found that less than one and half percent—three cases, the *Alholmens Kraft* Case, the *Roine* Case and the *Finnpulp* Case¹⁵⁴—discussed modelling extensively. Yet in none of them did the Court interfere with the modeller's inferential process.¹⁵⁵ The Court may have *described* the process but it did not, for example, remit a case to administration, calling for updates or amendments to the model, or request for new impact estimates created with an amended model.¹⁵⁶

At the end of the day, a line seems to have been drawn between facts and values in Finnish judicial review.¹⁵⁷ Tentatively due to the expertise readily at hand, the Court can identify the cases in which modelling has not been of the desired quality. It can explicate the frailties it recognises, and analyse the uncertainties and the risk of

151 *Finnpulp case* at 4.2.4; EPA s 54. The two dissenting judges (one legally trained, one expert judge with technical background) would have amended the permit conditions so as to include an obligation to conduct specific investigations in five and ten years' time, see the *Finnpulp case*, Dissenting opinion.

152 Preston (n 14) 139–40. Also, the overall argumentation on models and their legal implications is greatly reminiscent of the arguments identified by Fisher and others (n 9) 259.

153 Text to n 168.

154 Respectively, texts to n 120, n 104 and n 141.

155 Text to n 13.

156 There may have been practical reasons for the reluctance to remit: going through the whole process again would protract the already long processes.

157 Text to n 40.

detrimental outcomes. If the model is found to be unsatisfactory or unsuitable, the Court disregards it and the information it produces. Instead of relying on the model, the Court relies on the source data instead—in other words, it replaces the model producing under-par environmental impact assessments with its own understanding of the likely future impacts. If the stakes are high enough, disregarding the inapt model can even leave room for direct application of the precautionary principle: if better scientific assessments or legal mechanisms are not available or are found inadequate, the Court is left with balancing of principles.

Based on our analysis, it appears that models are placed under strict scrutiny in Finnish judicial review. They are expected to show, with high enough confidence, the expected impacts on waters, and if they fail to do this—because of the high uncertainties or otherwise—they risk being regarded as useless.¹⁵⁸ The uncertainty and limitations in the modelling process become the pivotal question of whether to trust the model at all. This is partially a consequence of the fact/value separation. When reforming the permit but not the model is accepted, the latter can quickly face full rejection, if full acceptance is the only other option. Especially in major undertakings—such as the Finnpulp plant—the legal mechanisms may not be that useful when most of them operate with the temporal aspects. When simultaneously the size of the project increases the risks, the modelling may quickly seem under-par when compared with the requirements of the precautionary principle.

This brings us back to the relations between scientific uncertainty assessment and environmental principles, our porous yet prevailing boundary between science and society. As Scotford points out, environmental law is immersed in principles that have been readily adopted around the globe but remain vague in essence.¹⁵⁹ Our case study made the legal and non-legal application of these contingent principles prominent.¹⁶⁰ Most of the legal mechanisms we identified belong to the Court's toolbox for promoting precaution without needing to engage directly in the weighing and balancing of principles.¹⁶¹ As we have seen, the precautionary action against detrimental outcomes begins as early as the modelling and continues in decision-making and judicial review, exemplifying an evolution of factual–evaluative complexes. According to Del Mar, these devices 'can be profitably analyzed, and explained, as having on the one hand a factual side, and on the other, an evaluative side'.¹⁶²

If accepted, this notion calls for reconsidering forms of legal reasoning, the definition of 'legal' in particular.¹⁶³ In the cases examined, the fact/value distinction was

158 According to our case analysis, the SAC has thus been successful in recognizing 'junk science', Pascual and others (n 11) 470.

159 Scotford (n 17) 1–5.

160 *ibid* 3.

161 In other words, employing the legal mechanisms overcame the first condition of applying the principle: the threat of serious or irreversible damage, Preston (n 14) 129ff. Conservative application of weighing and balancing of principles is a common trait in Finnish judicial review, familiar from Dworkin's thinking, in which principles were the last resort when rules had failed, Ronald Dworkin, *Taking Rights Seriously*, New Imprint with Appendix: A Reply to Critics (Duckworth 1978) 187ff. Arguing with principles is reserved for the 'hard cases', most difficult and few in number.

162 Del Mar (n 40) 63, using the concept of 'vulnerability' as an example.

163 Sustainable environmental governance tends to induce such needs, Fisher (n 127) 57.

upheld in Court, and judicial reasoning was grounded in an accurate understanding of models and their output, and the line of approved review—ie review that does not necessitate rendering the matter back to the first instance for reconsideration of facts—was drawn between permit conditions (reviewed) and modelling (withheld). Though formally legitimate, the questions we touched upon at the outset linger.¹⁶⁴ Comprehending uncertainty assessments as a continuum makes the constitutional constraints obstructing review of all mechanisms addressing the uncertainty appear obscure or arbitrary.¹⁶⁵ If the focus is on the axiological choices shaping the legitimacy of the proposed project, should the line rather not be drawn at the decision over parameters, choice of competing models, or some other point of the modeller's inferential process? Also, a more diverse toolbox for addressing the continuum than merely disregarding inadequate models might advance the same end. Discussing the boundaries might simultaneously enhance transparency and open argumentation. Approaching the uncertainty assessment gradually by default—first with the scientific, then with the legal mechanisms—would counteract the risk of leaving axiological decisions hidden within scientific evaluations.

From a comparative perspective, these thoughts further emphasise the contingent nature of environmental law.¹⁶⁶ This holistic approach to the administration of environmental impact assessment underscores the differences in national administrative–legal procedures on courts' faculties for reviewing the factual matters.¹⁶⁷

5.2 Legal Mechanisms Advancing Reciprocity, Relying on Model Transparency

As has been emphasised earlier, the puzzle is not merely a legal dilemma solved within the legal sphere—not even in a jurisdiction of expert judges.¹⁶⁸ The cases we analysed also offer many practical learning points for modellers wishing to advance the usefulness of models in the legal context. In the *Turku Case* we were left wondering whether the Court could have reasoned its decision better if it had more detailed information about the modeller's realities and decisions.¹⁶⁹ Thus, we concur with the stance that there is a need to make the modelling process transparent and disclose their inferential methods.¹⁷⁰ A more transparent and systematic way of dealing with the uncertainties and reducing subjectivity in the modelling procedure and outcome assessment could be achieved with following good modelling practice and reporting the model structure, the limitations in its use, the simplifications and assumptions, the uncertainty sources and their effect on the model output.¹⁷¹ Also courts with

164 Text to n 6.

165 Text to n 69.

166 Pedersen (n 17).

167 Paloniitty and Eliantonio (n 84).

168 Text to n 52; Fisher and others (n 4) 1718, 1721.

169 Text to n 116.

170 Pascual and others (n 11) 429, 470–1. Achieving full transparency may be wishful thinking. Modelling is a form of evolution, new models building on the earlier ones, thus disclosing all assumptions and their relevances becomes a trial, Isabelle Stengers, *Cosmopolitics II* (Robert Bononno tr, University of Minnesota Press 2011) 269–83, 273.

171 This makes the boundary between the modeller and decision-maker less opaque by increasing the model's credibility and trust amongst the decision-makers, GAK van Voorn and others, 'A Checklist for

fewer resources than the Court at hand might benefit from more transparent modelling practice: it might help in reviewing whether a manifest error has occurred, or an unreasonable or irrational decision delivered.¹⁷²

If modellers want their work to be correctly understood in courts, they should take care to identify, estimate, quantify and especially communicate the uncertainties accurately.¹⁷³ Any limitations in temporal or spatial scales should be stated clearly. The quality of the input data and the resulting limitations on the range of use for the model should be explained in terms of the intended use of the model—as seen in the *Finnpulp* Case, models for coastal waters are not necessarily apt for inland lakes.¹⁷⁴ Sensitivity to alternative inputs or assumptions should be documented. Iterative updating of the model structure and parameters and use of up-to-date monitoring data would eventually reduce the models' uncertainties and thus enhance their predictive capability.¹⁷⁵ When this is done, reciprocal action and decisions on the permissible level of uncertainty, or the level of acceptable risk, could be left for the legal sphere to make.

When dealing with iterative processes, enhancing transparency may simultaneously advance reciprocity and adaptivity. In modelling, assessment of accuracy happens alongside learning. Modelling should be adaptive in such a way that it can effectively use prior knowledge and data and update the predictions whenever new information is obtained.¹⁷⁶ The rulings we examined illustrate how courts can accommodate the reality of modelling, and incorporate at least weak traces of adaptivity and reciprocity in the governance system. Firstly, the courts can shorten the time before the authorization needs to be revised in the administration (the *Lakeuden Vesi* Case).¹⁷⁷ Secondly, the courts can require updated information: when the models were criticised as outdated at the outset, the Court demanded that a revised model be presented at the time of permit revision (the *Salo II* Case).¹⁷⁸ Thirdly, the courts can require active monitoring to receive up-to-date information about the development of the recipient (the *Turku* Case).¹⁷⁹ Fourthly, courts can couple the individual authorization's duration to the schedules of other information sources, as was done when the permit's length was harmonised with WFD's RBMP cycles. The RBMP's 6-year cycle resulted in the permit being re-evaluated right after the new RBMP was published, and the new information could be used to assess the undertaking's permit

Model Credibility, Salience, and Legitimacy to Improve Information Transfer in Environmental Policy Assessments' (2016) 83 *Environ Modell Softw* 224.

172 Fisher (n 9) 260; the EU law obligations towards that end are analyzed in Mariolina Eliantonio, 'The Impact of EU Law on Access to Scientific Knowledge and the Standard of Review in National Environmental Litigation: A Story of Moving Targets and Vague Guidance' (2018) 27(4) *EEELR* 115; for the Irish developments see Aine Ryall, 'Enforcing the Environmental Impact Assessment Directive in Ireland: Evolution of the Standard of Judicial Review' (2018) 7(3) *TEL* 515.

173 Uusitalo and others (n 41).

174 Text to n 148.

175 Text to n 19ff; Jakeman and others (n 22); Schuwirt and others (n 138).

176 Meaning that modelling reflects the principles of adaptive management, Paloniitty (n 6) 54–104; Preston (n 14).

177 Text to n 124. As was voiced in the *Finnpulp* case, the option was recently made unavailable in Finland, text to n 150.

178 Text to n 130.

179 Text to n 116.

conditions in revision (the *Lakeuden Vesi* Case).¹⁸⁰ These cases are promising signs of the courts' capabilities to respond to the challenge.

The beginning of the path forward is thus identified for both sides: modellers to enhance their practice and the courts to continue recognising the gradually decreasing scientific uncertainty in their rulings. Uncertainty assessment is one continuum and transparent reduction of it is another, but the latter is also a reciprocal exercise. The trick for both trades is to negotiate the right balance of these continuums. If allowed, environmental models and their judicial review could ebb and flow between the factual and normative worlds, making the most of both and their common ground, the precautionary principle.

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180 This mechanism also embodies the CJEU's notion that 'it is impossible to consider a project and the implementation of management plans separately', the *Weser* case (n 60) [47].